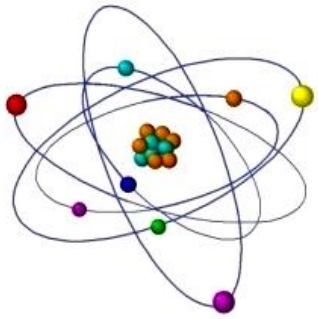
A RETROSPECTIVE ANALYSIS OF CT COLONOSCOPY OF 7 YEARS EXPERIENCE IN A CLINICAL PRACTICE



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ABSTRACT*: Timely diagnosis of cancerous and non-cancerous colon diseases is one of the pressing issues of modern medicine. Colorectal cancer is a significant problem for the world population due to its high prevalence and mortality rates and the considerable financial costs associated with this disease, and its possible complications. CT colonography is a highly informative and less invasive imaging method of the large intestine. Despite worldwide implementation into clinical practice, especially in the USA and Western European countries, it is rarely used in Georgia. The study aims to increase the effectiveness of diagnosing pathologies of the large intestine in our country by promoting the widespread implementation of the CT colonography method in clinical practice and improving the techniques of conducting the study and interpreting the results. The study took place in the Batumi referral hospital, where CT colonography was introduced into clinical practice in 2015, after which it has been actively used and becoming more popular daily. The material was collected from May 15, 2015, to October 31, 2022. A total of 352 CT colonography were performed in the mentioned period. By analyzing the data of our examined patients and statistical processing, we obtained the following results: sensitivity of CT colonography in the diagnosis of congenital anomalies of the colon is 98.0%, specificity - 100%, diagnostic accuracy - 98.2%; in the diagnosis of diverticula, respectively: 92.3%, 95.1%, 92.7%; In the diagnosis of polyps: 87.3%, 85.6%, 85.9%. Based on the obtained results, it can be concluded that CT colonography is an accurate, highly informative, and less invasive method of colon examination; Colorectal cancer screening performed with it is less invasive, less time-consuming, and as effective as optical colonoscopy; one of the most prominent advantages of CT colonography is the ability to detect non-intestinal pathologies. Improving the technical parameters of CT colonography will allow us to reduce radiation exposure levels for patients while maintaining image quality.*

Key words: Virtual CT Colonoscopy, Virtual Colonoscopy, CT Colonography

INTRODUCTION

Timely diagnosis of cancerous and non-cancerous colon diseases is one of the important issues of modern medicine. According to the statistics of the International Agency for Research on Cancer (IARC) in 2020, colorectal cancer is the third most common malignant tumor in the world and the second most common cause of cancer-related deaths (Fig. 1) [1]. Colorectal cancer is a big problem for the world population due to its prevalence, high mortality rate, and the significant financial costs associated with this disease and its possible complications [2,3].

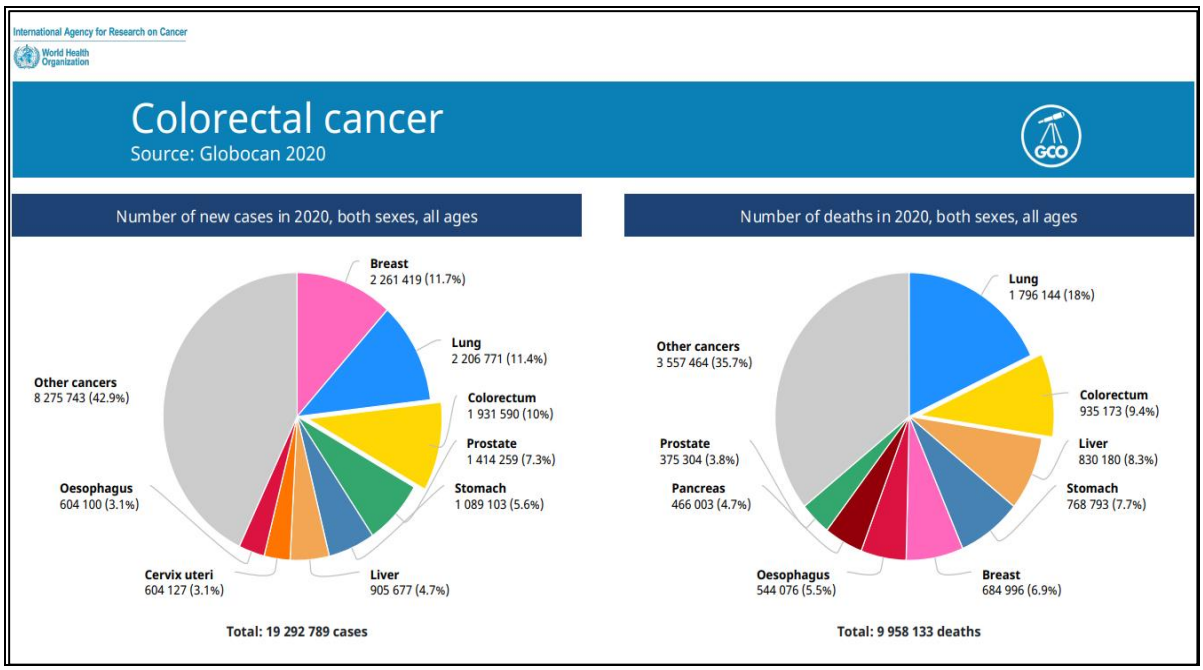

Figure 1. International Agency for Research on Cancer (IARC) 2020 statistics.

In addition, it should be noted that the number of patients with colorectal cancer and other various pathologies of the large intestine (Crohn's disease, diverticulosis complications) is increasing irreversibly. Despite the above, the number of deaths caused by colorectal cancer in recent decades has also decreased, which is a direct result of the improvement of its screening, treatment, and diagnostic methods [1,4,5,6,7].

Nowadays, the primary methods for diagnosing pathologies of the large intestine are irrigoscopy-irrigography, optical colonoscopy, computer tomography, and CT colonography; In recent years, colon ultrasound and MRI-colonography have been actively used in clinical practice [8,9]. Each method has its advantages and disadvantages, but none of them can provide a complete study of the large intestine.

CT colonography is a highly informative and less invasive diagnostic method, detecting pathological changes in the colon wall and diagnosing cancer at an early stage [7,10,11,12,13]. With its help, a qualified and experienced radiologist can assess the shape, location, contours, haustration, folds, lumen, wall thickness, and the surface of the colon, detect the pathological area and determine its exact location, assess the degree of tumor invasion, the condition of surrounding tissues and lymph nodes, identify regional and distant metastases, assess the state of other organs in the abdomen [3,6]. Compared to colonoscopy, the examination is quicker and less invasive, it is elegant and comfortable, does not require sedatives and analgesics, and has a lower probability of complications, including a small risk of perforation (1-2:20,000); Due to these properties, unlike optical colonoscopy, its repeated use does not represent significant discomfort for the patient [2,3,4,5,14].

CT colonography is currently one of the main methods of diagnosing colon diseases in the USA and Western European countries; In addition, in some advanced countries, it is included in the colorectal cancer screening program; For example, CT colonography is supported by the US Preventive Services Task Force (USPSTF) as one of the main methods of colorectal cancer screening for medium-risk patients [5,15,16].

Despite the widespread implementation of CT colonography in clinical practices worldwide, especially in the USA and Western European countries, and its high diagnostic capabilities, the method is rarely used in Georgia. The study aims to increase the effectiveness of the diagnostics of large intestine pathologies in our country by promoting the widespread implementation of CT colonography in medical practices and improving the methodology and interpretation of the results.

MATERIALS AND METHODS

The study was conducted based on the Batumi referral hospital, where CT colonography was introduced into clinical practice in 2015, after which it was actively used and becoming more popular by the day. The materials were collected from May 15, 2015, to October 31, 2022. A total of 352 CT colonography were performed in the mentioned period.

In all cases, the patient was familiarized with the necessary information about the procedure and signed the voluntary informed consent to participate in the study, following the form developed by us based on literary material, which was approved by the Biomedical Research Ethics Committee of Tbilisi State Medical University on October 15, 2017 (committee meeting N4-2017/64, 15th October 2017). During the clinical study, the patient's complaints, disease anamnesis, and clinical examination data were studied in detail. Among the instrumental methods, CT colonography, optical colonoscopy, irrigography-irigoscopy, gastrointestinal kinetic radiography, colon ultrasound, and MRI examination were performed.

CT colonographic studies were performed on a GE Brivo CT 385 16 Slice machine according to the following steps:

- Determination of examination indication,
- Intestinal preparation,
- Insufflation,
- Receiving images,
- Image processing and interpretation.

CT colonography indications are patients over 50, positive fecal occult blood test (FOBT), anemia of unknown origin, constipation for more than 72 hours, and others; it is especially the method of choice, in cases of contraindications to optical colonoscopy, the patient's fear or refusal of it, during unsuccessful or incomplete optical colonoscopy, for studying the prestenotic part of the large intestine inaccessible to optical colonoscopy, for patients with a history of allergic reactions associated to optical colonoscopy (for example, to sedatives and analgetics), cardiovascular system pathologies and diverticulitis (due to the risk of intestinal perforation).

Bowel preparation involves following a specific diet, taking laxatives, and contrast for marking fecal masses. A part of the researchers believe that adherence to the diet does not have a significant impact on bowel preparation and that the reduction of the dose of laxatives does not reduce the informativeness of the research due to the contrast marking of fecal masses and the use of the digital erasure function; According to their data, the use of the mentioned method together with the optimal efficiency of bowel preparation significantly reduces the discomfort of patients concerning CT colonography [14,17,18]. Despite the above, since we did not have any previous experience using CT colonography in our clinic, we gave priority to the more common method of bowel preparation, although we provided information to the patients about the simplified methods of bowel preparation and gave them a choice. It should be noted that the vast majority of patients chose the classical method of preparation due to the higher probability of obtaining higher-quality CT images.

According to the more common method of preparation of the bowel, patients refrained from eating vegetable food for 2-3 days before the examination; the day before the study, only liquid foods were allowed, for example, filtered meat broth, clear fruit juice without pulp, jelly and only until 13:00.

As a laxative, we used Fortrans (polyethylglycogen), which, along with the complete cleaning of the intestinal lumen, provides its optimal expansion at the expense of reducing the release of electrolytes. It is taken the day before the examination between 15:00 and 19:00 with the following dose: 1 package for every 15-20 kg of body weight dissolved in 1 liter of water. The patient takes the solution by sipping it gradually for 1 hour.

We used Omnipack (350 mg iodine/ml) for fecal mass contrast marking, 50 ml of which was diluted by the patient in 250 ml of cold water, and the resulting 300 ml aqueous solution was taken gradually per os the day before the examination between 21:00 and 22:00.

Before the study, we filled the colon with gas, for which we mostly used atmospheric air, rarely carbon dioxide or their mixture. Air was injected manually or with an insufflator, as well as by a mixed method. 30-45 minutes before insufflation, to relieve/prevent colon spasm, patients took 80 mg (two pills) of NO-SPA (Drotaverine) with 0.5 L of water, and another 0.5 L of water immediately before the start of the scan (water should be taken to better visualize the stomach and loops of the small intestine).

Out of 352 examined patients, in 332 cases - the colon was insufflated using atmospheric air manually, in 5 cases - with a CO_2 insufflator, and in 15 cases - using a mixed method.

Adequate distension of the colon, as well as proper bowel cleansing, is critical to the technical success of the examination, although patient safety, as well as comfort, must be considered. Because of this, in cases with patients with diverticular disease, we inflated the colon using a carbon dioxide insufflator. Continuous delivery of CO_2 at low pressure reduces colonic spasms, especially in segments with diverticula. Meanwhile, rapid resorption of carbon dioxide in the colonic wall results in improved comfort levels post-procedure.

For the manual method, we inflated the intestine with atmospheric air. We used relatively small flexible rectal balloon catheters and syringes with catheter tips. After inserting the rectal probe, the air was administered using a syringe; The amount of insufflated air was controlled by the patient and the medical staff (radiologist or CT operator) until the maximal tolerable limit was reached; Between insufflations, the air was blocked using a clamp. At the same time, the degree of colon distension was evaluated and controlled by CT scout images before the examination. In case of inadequate insufflation of the intestine, we performed additional air administration in agreement with the patient. With the protocol used at our institution, inadequate segmental dilation occurred in less than 1% of cases.

CT scans were performed using a pitch of 1.25 mm and slice thickness of 1.25 mm. Rotation time was set at 1.0 s, table movement speed at 27.50 mm/s, and X-ray tube potential at 100-120 kVp. Patients were scanned in both supine and prone positions in the craniocaudal direction. To obtain optimal image quality for the assessment of abdominal organs, in the supine position, scanning was performed at 120 mA, and for scanning in the prone position, 80 mA was used to reduce dose exposure; If there was a suspicion of, for example, liver metastases, we resorted to contrast enhancement, for which we used 100-130 ml of Omnipack (350 mg iodine/ml), which was injected intravenously with a delay of 60 seconds at 3.5-4.0 ml/s, during the examination with the patient supine. Before the scan, patients were instructed to take a deep breath and hold it; If they were incapable of holding their breath, they were advised to exhale slowly throughout the examination. At the end of each examination, the effective radiation dose was calculated.

Correct radiation dose management is imperative when performing CT colonography for colorectal cancer screening, as the examination may be repeated several times during an individual's lifetime. Therefore, there must be a balance between the overall benefit of screening and any theoretical risk of radiation exposure. Also, the balance between radiation dose and image quality must be maintained during the examination. Adequate preparation of patients for CT colonography and their proper positioning during the examination ensures the avoidance of repeated scans, therefore, additional radiation exposure. Currently available techniques for reducing the radiation dose during the scan include reducing the current force or voltage, automatic current modulation, and iterative reconstruction techniques.

Scans were processed and evaluated with GE AW Volume share 5 Colon VCAR EC software. Using the program Colon VCAR, parameters of the study window were automatically determined, 2D and 3D images were obtained, 120 and 360-degree panoramic images and endoluminal 3D models were formed. In case of insufficient insufflation of the large intestine, the automatic construction of the endoluminal 3D model is not possible and instead, the so-called "empty" or "blind" areas are obtained; In these cases, we formed the endoluminal 3D model manually.

We start the interpretation of the study with the 3D aerogram: we evaluated the shape, location, contours, haustration, and width of the lumen along the entire length of the colon. At this stage, we can identify anatomical variants and anomalies, diverticulum, signs of chronic inflammation, stenosis, and ileocecal (Bauhin's) valve incompetence (Fig. 2.2.2).

Figure 2.2.2. CT colonography: 3D aerogram (dolichocolon, exophytic cancer, endophytic cancer)

In the next stage, the lumen of the intestine was examined in the endoscopic window mode in the direction of the ednoluminal model, which is created either automatically or manually. The inner surface of the intestine and the nature of the folds were evaluated in order to identify lesions, stenosis, and diverticula (Fig. 2.2.3).

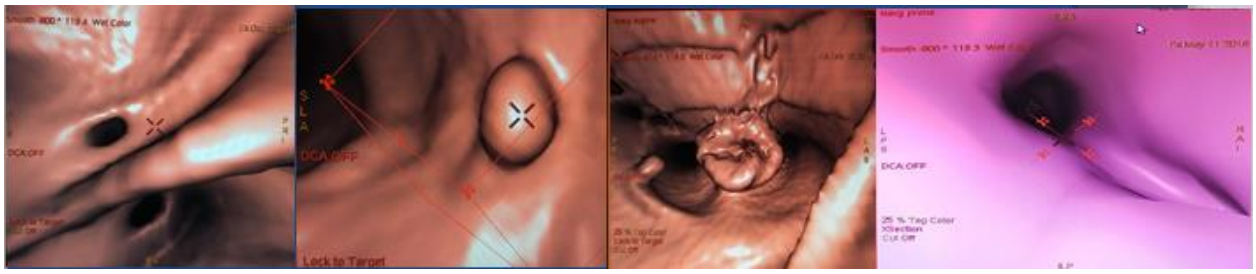

Figure 2.2.3. CT Colonography: endoscopic window (diverticulosis, polyp, exophytic cancer, and polyp, stenosis-endophytic cancer)

Through the virtual biopsy program, in the endoscopic window mode, it is possible to conduct differential diagnoses between different types of lesions, for example, polyps and cancer. Using the virtual biopsy (digital mapping) feature, it is possible to map the internal architecture of a polypoid lesion. Thus we can quickly and efficiently distinguish suspicious soft tissue lesions from false polyps, reducing the overall time of interpretation by reducing the number of 2D correlations required (Fig. 2.2.4).

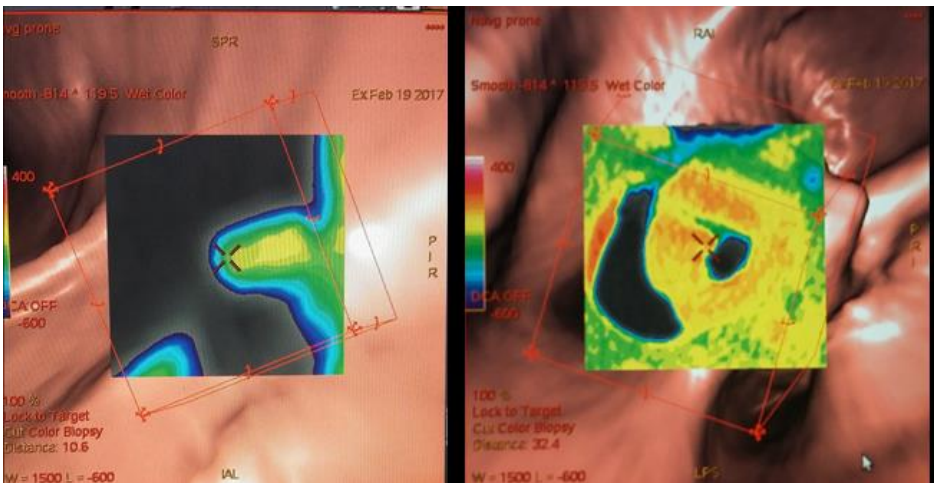

Figure 2.2.4. CT Colonography: virtual biopsy (polyp, exophytic cancer)

Virtual dissection mode is an innovative method in which a three-dimensional (3D) model of the large intestine is virtually opened, dissected, and displayed as a three-dimensional planar image of the mucosal surface, similar to a macroscopic pathoanatomical specimen. Evaluation of the plane image of the inner surface of the intestine obtained at this time facilitates the detection and assessment of diverticula, polyps, cancer, and other lesions, chiefly through digital labeling. Using this method, the 3D image of the colon is evaluated faster than it is possible with the endoscopic window mode, which in itself reduces the time of evaluation of the study; In addition, it is possible to increase the accuracy of the examination by minimizing the amount of the "blind zones" that accompany the endoscopic window mode (Fig. 2.2.5).

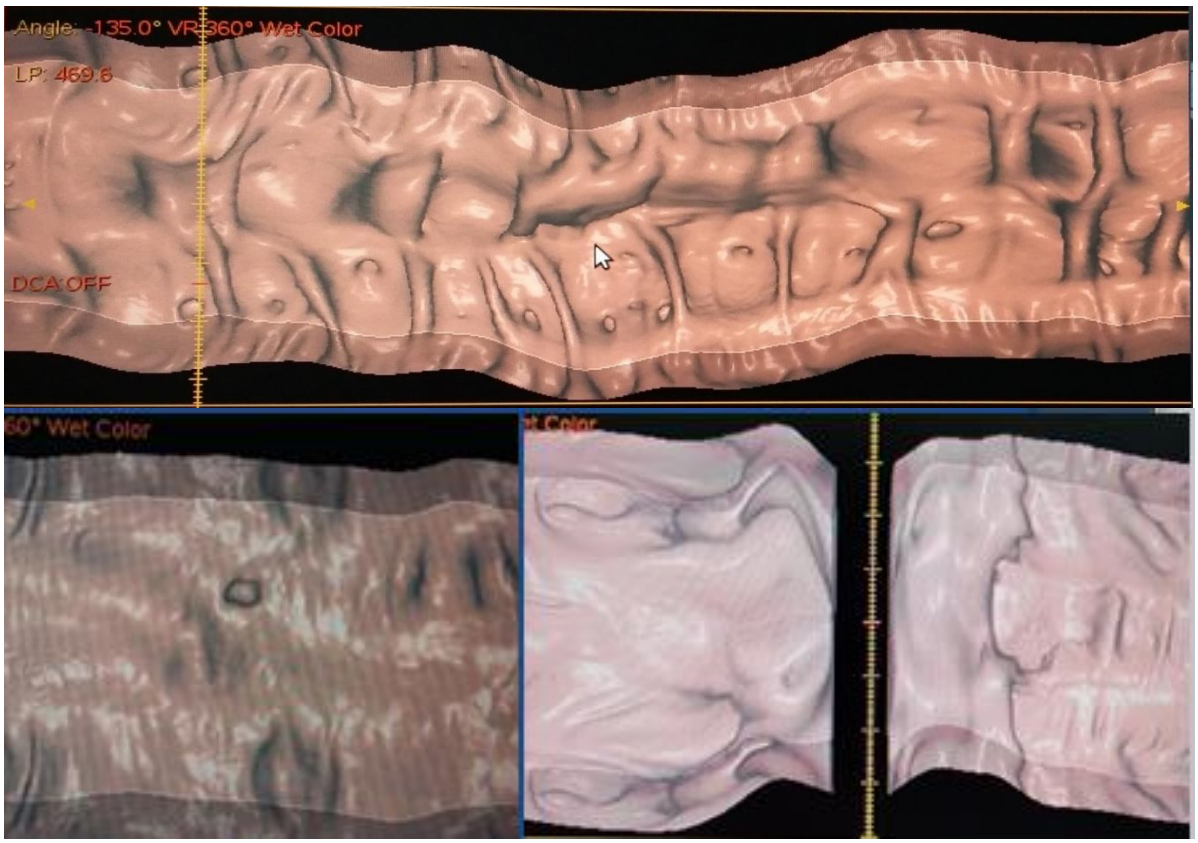

Figure 2.2.5. CT Colonography: virtual dissection (diverticulosis, polyp, stenosis-endophytic cancer)

Using the digital marking function, even small lesions of 2-4 mm in size, such as polyps, can be easily detected (Fig. 2.2.6).

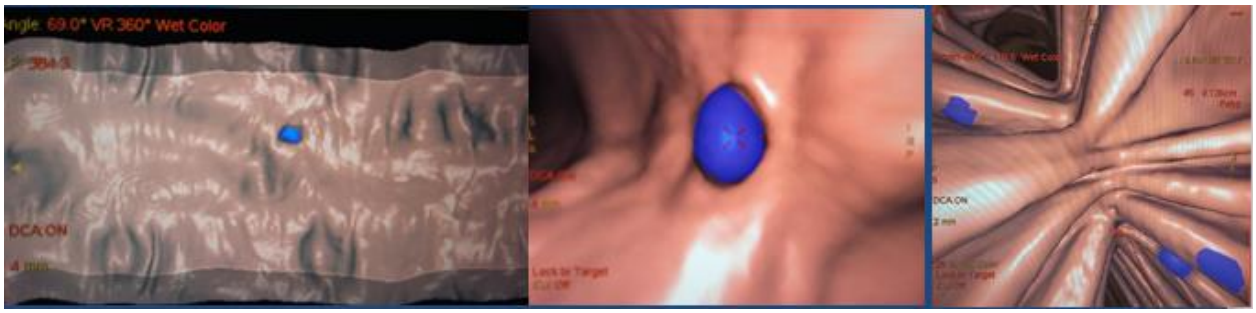

Figure 2.2.6.CT Colonography: digital marking (polyp, polyposis)

Axial slices were used to assess the thickness of the intestinal wall, the degree of tumor invasion, the condition of the surrounding tissues and lymph nodes, and other abdominal organs (Fig. 2.2.7).

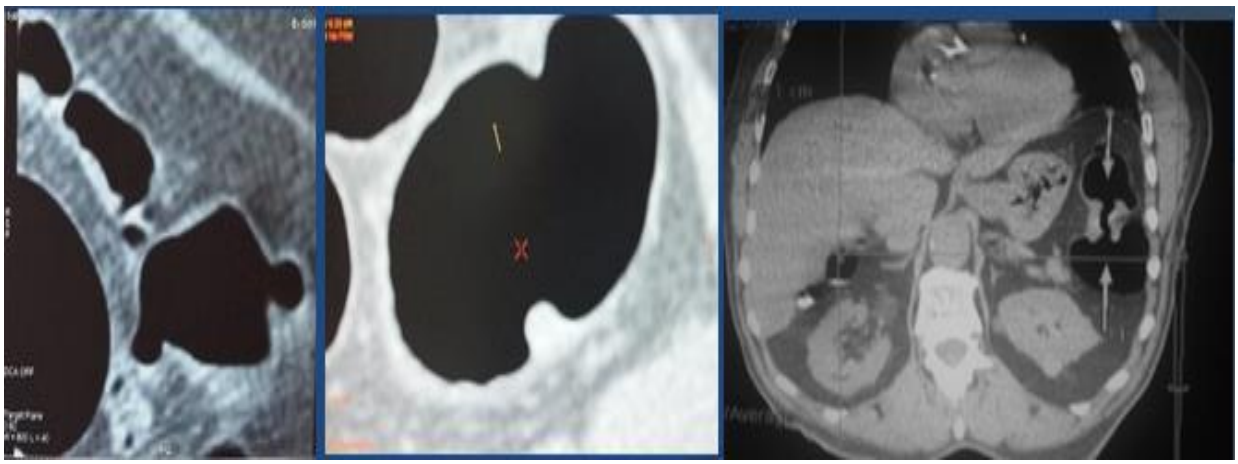

Figure 2.2.7. Axial slices: diverticulosis, polyp, endophytic cancer

By administering per os contrast agent and using the "digital cleaning" function of the image, it's much easier to differentiate small polyps from other types of lesions or fecal matter. (Fig. 2.2.8).

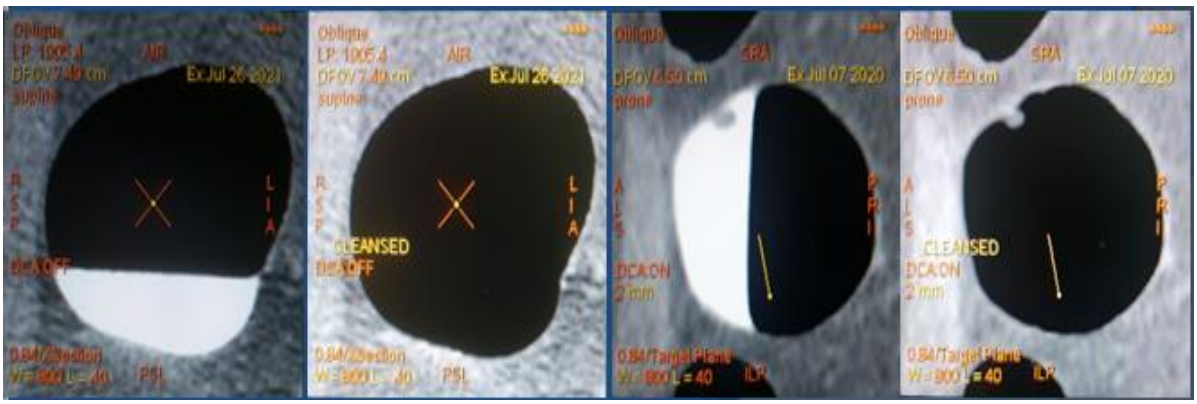

Figure 2.2.8. CT Colonography: "digital cleaning" (norm, polyp).

Along with many positive features, CT colonography also has some disadvantages, which, along with radiation exposure and an uncomfortable attitude towards the process of colon preparation for a large number of patients, can manifest in difficulty and sometimes impossibility of interpreting the study, which can be the result of both improper preparation of the intestine and inadequate inflation and/or collapse of its segments.

Unfortunately, cases of inadequate inflation and/or collapse of the intestine are most often found in the segments characterized by a high incidence of colorectal cancer - the rectum and sigmoid colon; Diverticular disease is also common in the sigmoid colon. Both pathologies are difficult to diagnose by CT colonography under the mentioned conditions, which makes it necessary to solve or reduce the problem created by inadequate bowel inflation, which we did by maximum air insufflation up to the limit tolerated by the patient, which was immediately followed by scanning. In this way, it was possible to obtain an image during the peak distension of the colon.

We overcome the complication of colonic evaluation by residual stool and fluid by comparing supine and abdominal images, per os contrast labeling of fecal masses, digital sweep, and digital mapping (virtual biopsy) functions (Fig. 2.2.9).

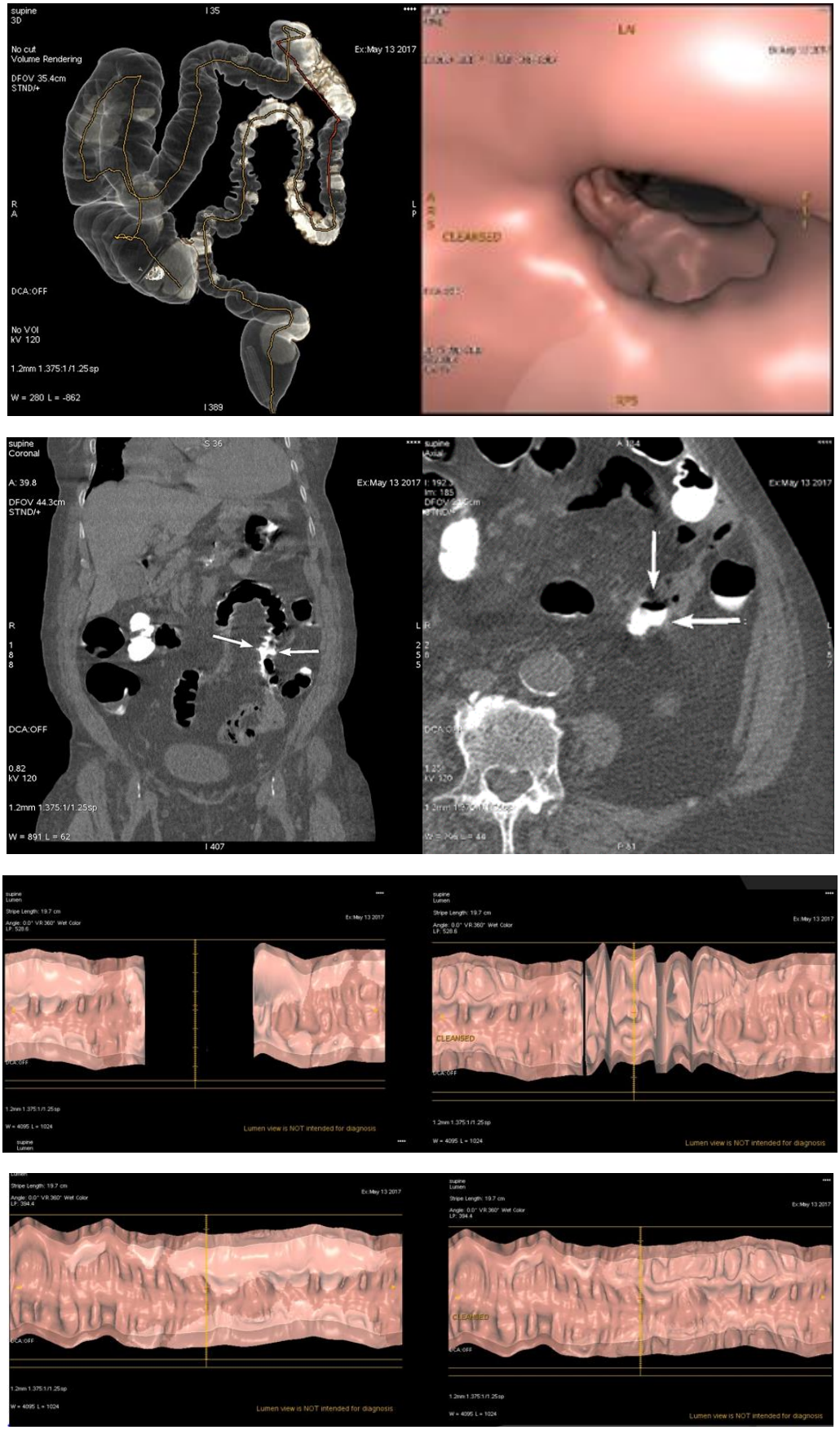

Figure 2.2.9. inadequately insufflated sigmoid colon with fecal masses

The vast majority of potential pitfalls in the assessment of the study can be adequately addressed if the technical requirements for performing a CT scan, including patient preparation, colonic insufflation, and scanning protocol, are handled appropriately.

Most of the patients from the main study underwent colonoscopy, as it is the "gold standard" for colonic examination. An optical colonoscopy was performed in the endoscopy department using Olympus Evis XI CV-1500. Colonoscopy and post-surgical data were used as reference methods. If necessary, a biopsy or removal of a bulky mass was performed, followed by a histological examination. Statistical data processing was carried out using the Microsoft Office Excel software package, mathematical support – SPSS.26 software package, and statistical analysis - standard methods of variational statistics; The reliability of the obtained numerical data was evaluated using Student's *t*-test. Data were considered statistically significant at $p<0.05$. The indicators of sensitivity, specificity, and diagnostic accuracy of the CT colonography method in detecting colon lesions were determined; Optical colonoscopy and results of surgical procedures were determined as reference methods.

RESULTS

Out of a total of 352 examined patients, 34(9.7%) were assigned a study after incomplete colonoscopy, 57(16.2%) - because of colonoscopy refusal, 3(0.9%) - due to colonoscopy contraindications, 230(65, 3%) - with clinical indications, 28 (7.9%) - for preventive purposes (diagram 2.1.1).

The age of the patients ranged from 17 to 91 years (average age - 56 years); 155(44%) of them were men, and 197(56%) were women (diagram 2.1.2).

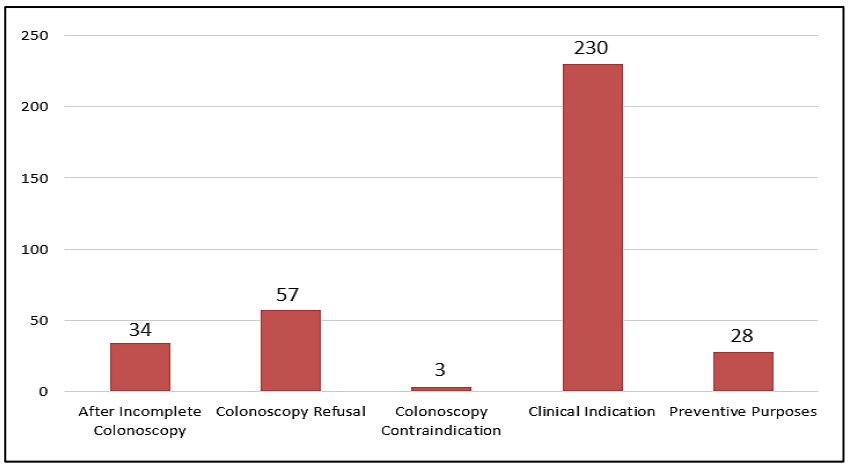

Diagram 2.1.1. Distribution of patients according to the indication of CT colonography.

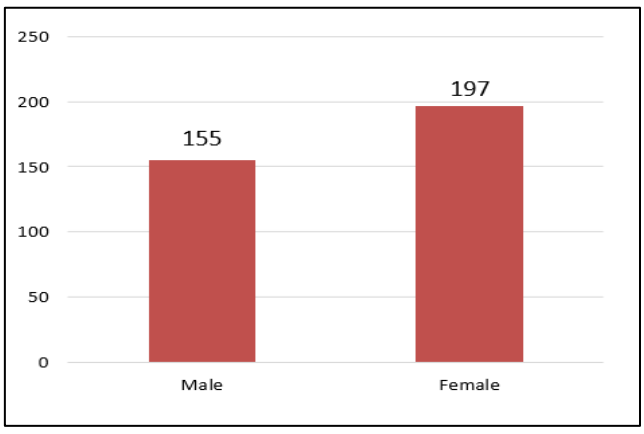

Diagram 2.1.2. Distribution of patients by gender.

Studying the CT colonographic research data of 352 patients, 258(73.3%) were diagnosed with dolichocolon, 24(6.8%) - only dolichotransversophtosis, 40(11.4%) - only dolichosigma, 15(4, 3%) - cecal malrotation, 1(0.3%) - megacolon. 21(6.0%) patients were found to have diverticula, 81(23.0%) - diverticulosis. A single polyp was detected in 32 (9.1%) cases and polyposis in 7 (2.0%) cases. 14 (4.0%) patients were diagnosed with colorectal cancer (diagram 2.1.3). 21 patients underwent different types of colon surgery (diagram 2.1.4).

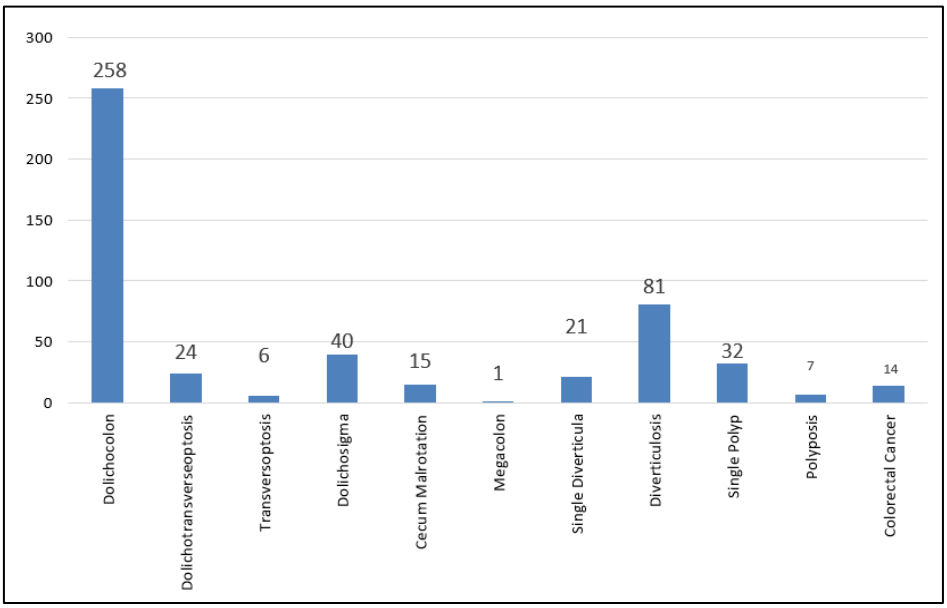

Diagram 2.1.3. Distribution of patients according to pathologies detected by CT colonography

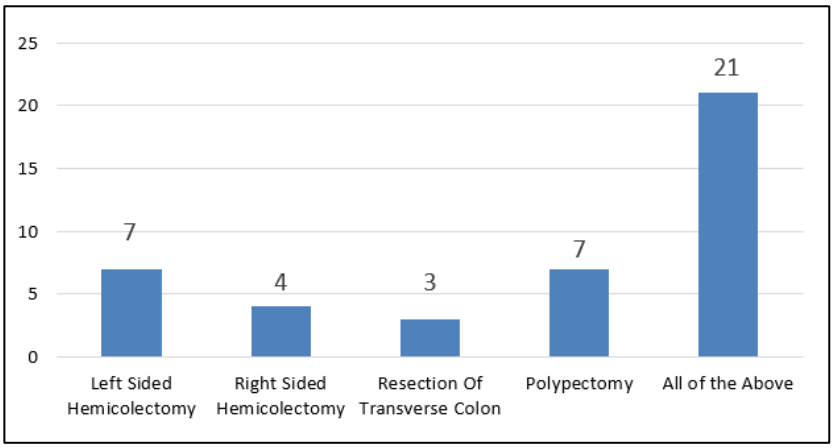

Diagram 2.1.4. Types of surgery performed

In addition to intestinal pathologies, extracolonic lesions were detected: 2 (0.6%) patients had peripheral lung cancer, - 1 (0.3%) sarcoidosis, - 182 (51.7%) hiatal hernia, 182 (51.7%) stomach cancer, - 2(0.6%), hepatosis - 115(32.7%), liver cyst - 17(4.8%), hepatocellular cancer - 1(0.3%), liver metastases - 5 (1.4%), gallstones - 22 (6.3%), spleen cyst - 2 (0.6%), adrenal gland adenoma - 5 (1.4%)), single and multiple kidney cysts - 72(20.5%), urolithiasis - 29(8.2%), uterine myoma - 9(2.6%), ovarian cyst - 5(1.4%), spinal hemangioma - 12(3.4%), spinal metastasis - 1(0.3%).

By studying the data of the patients examined by us and through statistical processing, we obtained the following results: sensitivity of CT colonography in diagnosing congenital anomalies of the large intestine is 98.0%, specificity - 100%, diagnostic accuracy - 98.2%; in diagnosing of diverticula, respectively: 92.3%, 95.1%, 92.7%; for polyps: 87.3%, 85.6%, 85.9%.

CONCLUSION

Based on the obtained results, it can be concluded that CT colonography is an accurate, highly informative, and less invasive method of colon examination; Colorectal cancer screening performed with it is less invasive, less time-consuming, and as effective as optical colonoscopy; One of the main advantages of CT colonography is the ability to detect non-intestinal pathologies. Improving the technical parameters of CT colonography will allow us to reduce radiation exposure levels of patients while maintaining image quality.

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